

In the Claims:

Please AMEND claims 45 and 56-57, and ADD new claim 58, such that the pending claims will read as follows:

Claim 1 (previously presented): An automated method for cleaning, rinsing and drying substrates comprising:

- providing a tank of fluid having a first portion and a second portion;

- submerging a first substrate in the first portion of the tank;

- cleaning the first substrate in the first portion of the tank;

- shuttling the first substrate from the first portion of the tank to the second portion of the tank via a shuttle;

- lifting the first substrate from the second portion of the tank to a drying region;

- returning the shuttle back to the first portion of the tank after the first substrate is disengaged from the shuttle;

- supplying drying vapor to an air/substrate/fluid interface as the first substrate is lifted;

- receiving a second substrate in the first portion of the tank;

- cleaning the second substrate in the first portion of the tank;

- fixing the first substrate in position for extraction from the drying region;

- shuttling the second substrate to the second portion of the tank; and

extracting the first substrate from the drying region;

wherein at least one of receiving, cleaning and shuttling the second substrate at least partially overlaps in time with lifting and extracting the first substrate.

Claim 2 (previously presented): The method of claim 1 wherein supplying drying vapor to the air/substrate/fluid interface comprises supplying a drying vapor that is miscible with the rinsing fluid, the drying vapor being absorbed at the air/substrate/fluid interface, and creating a lower surface tension than a surface tension of the rinsing fluid, thereby inducing a Marangoni flow; and Marangoni drying the surface of the first substrate as the substrate is lifted from the fluid.

Claims 3-21 (Canceled).

Claim 22 (previously presented): The method of claim 1 wherein cleaning the first substrate in the first portion of the tank comprises cleaning the first substrate with megasonic energy; and wherein cleaning the second substrate in the first portion of the tank comprises cleaning the second substrate with megasonic energy.

Claim 23 (previously presented): The method of claim 2 wherein cleaning the first substrate in the first portion of the tank comprises cleaning the first substrate with megasonic energy; and wherein cleaning the second substrate in the first portion of the tank comprises cleaning the second substrate with megasonic energy.

Claims 24-40 (Canceled).

Claim 41 (previously presented): The method of claim 1 wherein supplying drying vapor to an air/substrate/fluid interface as the first substrate is lifted comprises supplying drying vapor via a linear nozzle.

Claim 42 (previously presented): The method of claim 1 wherein supplying drying vapor to an air/substrate/fluid interface as the first substrate is lifted comprises supplying drying vapor via a plurality of nozzles.

Claim 43 (previously presented): The method of claim 42 further comprising selectively turning on and off individual ones of the plurality of nozzles.

Claim 44 (previously presented): The method of claim 42 wherein each of the plurality of nozzles outputs a fan type spray.

Claim 45 (currently amended): The method of claim 1 wherein ~~shutting~~ shuttling the first substrate from the first portion of the tank to the second portion of the tank comprises ~~shutting~~ shuttling the first substrate in a horizontal direction.

Claim 46 (previously presented): The method of claim 1 wherein lifting the first substrate from the second portion of the tank to a drying region comprises lifting the first substrate into an enclosed drying region.

Claim 47 (previously presented): The method of claim 22 wherein cleaning the first substrate with megasonic energy comprises employing a transducer.

Claim 48 (previously presented): The method of claim 1 further comprising cleaning the first substrate in the second portion of the tank.

Claim 49 (previously presented): The method of claim 46 further comprising exhausting vapors from the enclosed drying region.

Claim 50 (previously presented): The method of claim 46 further comprising exhausting vapors from the enclosed drying region via a plurality of openings in a sidewall thereof.

Claim 51 (previously presented): The method of claim 1 further comprising rotating the first substrate within the first portion of the tank via a plurality of rollers.

Claim 52 (previously presented): The method of claim 1 wherein receiving the second substrate overlaps with lifting the first substrate.

Claim 53 (previously presented): The method of claim 1 wherein receiving the second substrate overlaps with extracting the first substrate.

Claim 54 (previously presented): The method of claim 1 wherein cleaning the second substrate overlaps with lifting the first substrate.

Claim 55 (previously presented): The method of claim 1 wherein cleaning the second substrate overlaps with extracting the first substrate.

Claim 56 (currently amended): The method of claim 1 wherein ~~shutting~~ shuttling the second substrate overlaps with lifting the first substrate.

Claim 57 (currently amended): The method of claim 1 wherein ~~shutting~~ shuttling the second substrate overlaps with extracting the first substrate.

Claim 58 (new): The method of claim 57 wherein lifting the first substrate from the second portion of the tank to a drying region comprises lifting the first substrate into an enclosed drying region.

THE INVENTION CLAIMED IS:

1. An automated method for cleaning, rinsing and drying substrates comprising:
- providing a tank of fluid having a first
- 5 portion and a second portion;
- submerging a first substrate in the first portion of the tank;
- cleaning the first substrate in the first portion of the tank;
- 10 shuttling the first substrate from the first portion of the tank to the second portion of the tank via a shuttle;
- lifting the substrate from the second portion of the tank to a drying region;
- 15 returning the shuttle back to the first portion of the tank after the first substrate is disengaged from the shuttle;
- supplying drying vapor to an air/substrate/fluid interface as the first substrate is
- 20 lifted;
- receiving a second substrate in the first portion of the tank;
- cleaning the second substrate in the first portion of the tank;
- 25 fixing the first substrate in position for extraction from the drying region;
- shuttling the second substrate to the second portion of the tank; and
- extracting the first substrate from the
- 30 drying region;
- wherein at least one of receiving, cleaning and shuttling the second substrate at least partially

overlaps in time with lifting and extracting the first substrate.

2. The method of claim 1 wherein supplying
5 drying vapor to the air/substrate/fluid interface comprises supplying a drying vapor miscible with the rinsing fluid being absorbed at the air/substrate/fluid interface, having a lower surface tension than a surface tension of the rinsing fluid, thereby inducing a Marangoni flow; and
10 Marangoni drying the surface of the first substrate as the substrate is lifted from the fluid.

3. An apparatus for drying a substrate, the apparatus comprising:
15 a first linear nozzle;
a fluid supply coupled to the first linear nozzle;
a second linear nozzle positioned proximate the first linear nozzle such that drying vapors therefrom
20 affect the fluid sprayed from the first nozzle to create a Marangoni drying effect;
a drying vapor source coupled to the second linear nozzle; and
a mechanism for passing the substrate past
25 the first and second linear nozzles within an operative distance such that the substrate is dried by the Marangoni drying effect.

4. The apparatus of claim 3 wherein the first
30 linear nozzle comprises one nozzle and extends the diameter of the substrate so that rinsing fluid spray wets each portion of the substrate's diameter.

5. An apparatus for drying a substrate, the apparatus comprising:

a first array of fan type nozzles which extends at least the radius of the substrate;

5 a fluid supply coupled to the first array of fan type nozzles;

a second array of fan type nozzles positioned proximate the first array of fan type nozzles such that drying vapors therefrom affect the fluid sprayed from the
10 first nozzle to create a Marangoni drying effect;

a drying vapor source coupled to the second array of fan type nozzles; and

a mechanism for passing the substrate past the first array of fan type nozzles and second array of fan
15 type nozzles within an operative distance such that the substrate is dried by the Marangoni drying effect.

6. The apparatus of claim 5 further comprising a controller operatively coupled to the first and second array
20 of fan type nozzles such that a plurality of the nozzles in the array can be independently turned ON and OFF, wherein the first and second arrays extend the diameter of the substrate.

25 7. A method of drying a substrate comprising:

spraying a fluid from a first linear nozzle at a surface of the substrate;

spraying drying vapors, from a second linear nozzle positioned proximate the first linear nozzle, to the
30 surface of the substrate such that the drying vapors affect the fluid sprayed from the first linear nozzle thereby creating a Marangoni drying effect at the substrate surface; and

moving the substrate relative to the first and the second linear nozzles within an operative distance such that the substrate is dried by the Marangoni drying effect.

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8. The method of claim 7 wherein spraying fluid from a first linear nozzle to a surface of the substrate comprises wetting the entire diameter of the substrate's surface.

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9. A method of drying a substrate comprising:
spraying a line of fluid to a substrate,
thereby creating an air/fluid interface line on the substrate;

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supplying a line of drying vapors to the air/fluid interface line, thereby creating a Marangoni drying effect along the air/fluid interface line; and
moving the substrate relative to the air/fluid interface line.

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10. The method of claim 9 wherein spraying a line of fluid comprises spraying fluid from a plurality of fan type nozzles.

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11. An apparatus for rinsing and drying a substrate, comprising:

a tank of fluid, for at least partially submerging a substrate, the tank comprising a first portion for receiving the substrate and a second portion that is horizontally adjacent the first portion; and

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a lift mechanism for lifting the substrate from the second portion of the tank.

12. The apparatus of claim 11, further comprising a substrate shuttle operatively coupled within the tank for receiving the substrate within the first portion and for shuttling the substrate to the second portion.

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13. The apparatus of claim 11, further comprising:

a drying vapor source positioned to supply drying vapors to an air/substrate/fluid interface formed as the substrate is lifted from the second portion of the tank by the lifting mechanism.

14. A method for rinsing and drying a substrate comprising:

at least partially submerging a substrate in a first portion of a tank of fluid; and

lifting the substrate from a second portion of the tank of fluid that is horizontally adjacent the first portion of the tank of fluid.

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15. The method of claim 14, further comprising shuttling the substrate from the first portion of the tank of fluid to the second portion of the tank of fluid.

16. The method of claim 14, further comprising supplying drying vapor to an air/substrate/fluid interface formed as the substrate is lifted from the second portion of the tank of fluid.

17. An apparatus for rinsing and drying a substrate comprising:

a tank of cleaning fluid, for submerging a substrate, the tank comprising a first portion for receiving

and cleaning the substrate and a second portion, operatively coupled to the first portion, for rinsing the substrate, the first and second portions being horizontally adjacent;

a lifting mechanism operatively coupled to
5 the tank for lifting a substrate from the cleaning fluid;
a drying vapor source positioned to supply
drying vapors to the air/substrate/rinsing fluid interface;
and

a substrate shuttle operatively coupled
10 within the tank for receiving the substrate within the first
portion and for shuttling the substrate to the second
portion.

18. The apparatus of claim 17, wherein the
15 apparatus further comprises a drying enclosure operatively
coupled above the second portion of the tank for receiving
substrates therefrom, wherein the drying enclosure encloses
the drying vapor source.

19. The apparatus of claim 18 further comprising:
20 a lifting mechanism for lifting a substrate
from the substrate shuttle to the drying enclosure.

20. The apparatus of claim 18 further comprising
25 a mechanism adapted to hold the wafer in a fixed position
relative to the drying enclosure.

21. The apparatus of claim 18 wherein the drying
enclosure further comprises a side wall having a sealable
30 opening for substrate extraction.